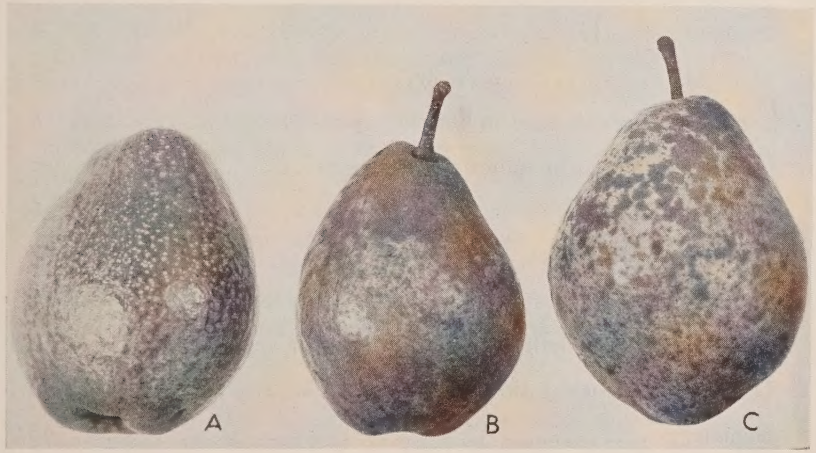
Sooty Blotch Disease of Pears and Its Control

By D. H. Palmiter



Sooty blotch infection on Kieffer pears. A, fruit free from infection; B, fruit infected early in June, showing dark russet areas where fungus has penetrated deeply enough to injure the epidermal cells; C, fruit infected at later date, with superficial fungous growth and little cell injury.

NEW YORK STATE AGRICULTURAL
EXPERIMENT STATION

CORNELL UNIVERSITY

GENEVA, N. Y.

Bulletin No. 734 November, 1948

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SOOTY BLOTCH DISEASE OF PEARS AND ITS CONTROL

D. H. PALMITER

INTRODUCTION

The disease now known as sooty blotch, *Gloeodes pomigena* (Schw.) Colby, was first found and described in 1832 on Newtown Pippin apples in Pennsylvania. The disease has since been reported from many states and other countries as a common infection on both apples and pears. It has been called many names, including fruit spot, ink spot, sooty fungus, sooty mold, sooty spot, cloud, and sooty blotch. From this list Colby (2),[1] in 1920, chose sooty blotch as being the most definite and most widely used, and it has since been generally adopted as the common name. Colby also established the scientific name, *Gloeodes pomigena* (Schw.) Colby.

This fungus was considered to grow only superficially on the surface of apple and pear fruits, without entering even the epidermal cells until Martin (5), in 1918, reported that the fungus on pears attacks the cuticle and then the underlying cells, causing the formation of suberized layers. Groves (3), in 1933, furnished definite proof that certain strains of the fungus penetrate the cuticle and the epidermis of the apple fruit.

In 1932, Baines and Gardner (1) isolated and cultured the sooty blotch fungus from apple and wild crab apple fruits and from the young twigs of 23 other species of trees, shrubs, and vines. They further demonstrated that spores produced by these isolations from other hosts would infect apples.

The fungus overwinters on infected twigs where spores are produced in small fruiting bodies called pycnidia. These spores mature 2 or 3 weeks after bloom, are washed about during rains, and start infections on the fruit. Fruit lesions may take from 30 to 75 days to become visible, according to Baines and Gardner (1), depending on weather conditions. They indicated that infections probably start in May or June but require a considerable period of cool (68° F) moist weather

[1] Figures in parenthesis refer to Literature Cited, page 14.

before sufficient growth has occurred to show as visible lesions. When hot or dry weather intervened after infections had started, the fungus development was very slow or completely suspended until lower temperatures and higher humidity conditions returned and allowed the colonies to enlarge and become pigmented and visible.

A second type of spore noticed by Colby (2) was described as chlamydospores with, "...dark brown, thick-walled, sometimes angled cells. They probably originate through the breaking apart of single cells of the mycelium." The role these spores may play in the spread of sooty blotch is not known.

On apples, sooty blotch is usually controlled by the sulfur sprays applied for apple scab. Pears, however, are often left without summer fungicide applications; and in such cases sooty blotch has been known to cause serious damage. Bordeaux mixture was suggested by Martin (5) to control this disease on pears. Under some conditions, however, serious injury has resulted from both sulfur and copper fungicides on pears, especially when summer oil is used for the control of pyslla.

The results of field experiments on Kieffer pears are reported in this bulletin in which dinitro materials were used in a dormant or greentip application in an effort to eradicate the overwintering stage of the sooty blotch fungus or reduce it sufficiently so that commercially clean crops could be produced without the use of summer fungicides or as a supplement to them (7).

METHODS

Field experiments were planned to test the effectiveness of dinitro materials as dormant sprays for the control of sooty blotch.

All sprays were applied with a high-pressure sprayer operated at 500 pounds. A single nozzle gun was used from the ground, and care was taken to wet all above-ground parts of the tree.

Applications were made when the fruit buds began to show some green tissue so as to coincide with recommendations for psylla control (Fig. 1).

At harvest, at least one half of the fruit from two or more trees in each plot was examined. Fruit free of blotch was classified as clean, that with a few light lesions passing U. S. No. 1 grade was listed as slight blotch, and the rest was listed as severe blotch. Severe blotch included those fruits on which the surface had become dark brown due to russet following the penetration of the epidermal cells by the

fungus. (See frontispiece.) Most of the light blotch is thought to have resulted from infections occurring so late in the season that cell penetration had not taken place.

FIG. 1.—*Greentip stage of Kieffer pear development, showing the proper time to apply dinitro materials for sooty blotch control.*

MATERIALS

All of the fungicides used in these experiments were furnished through the cooperation of the respective manufacturing companies. Those products bearing trade names were taken from the regular stocks as supplied to dealers.

DINITRO MATERIALS USED IN DORMANT SPRAYS

Elgetol.—A water slurry of the sodium salt of dinitro-ortho-cresol and a penetrating agent (18 per cent DNOC). Made by Standard Agricultural Chemicals, Inc., Hoboken, N. J.

Krenite.—A water slurry of the sodium salt of dinitro-ortho-cresol (20 per cent DNOC). Made by E. I. DuPont de Nemours Co., Wilmington, Del.

D–296.—A dry wettable powder containing 40 per cent dinitro-ortho-cryselate. Made by Dow Chemical Co., Midland, Mich.

D–389.—A liquid product containing a triethanol amine salt of dinitro-ortho secondary butyl phenol plus a wetting agent (25 per cent actual DNOSBP). Made by Dow Chemical Co., Midland, Mich.

D–289.—Same as D–389 but without the wetting agent.

D–489 or G–506.—A liquid containing an ammonium salt of dinitro-ortho secondary butyl phenol (25 per cent actual DNOSBP). Made by Dow Chemical Co., Midland, Mich.

Dinitro-sol.—A water suspension containing 5 per cent sodium dinitro-ortho-cresol, 15 per cent ammonium dinitro-ortho-cresol, and 14 per cent oxidized petroleum hydrocarbons. Made by Sherwin-Williams, Bound Brook, N. J.

Fungicides Used in Summer Applications

Micronized sulfur.—A dry wettable sulfur with average particle size of 3.5 microns. Made by Corona Chemical Division of Pittsburgh Plate Glass Co., Milwaukee, Wis.

Fermate.—A dry wettable powder containing 70 per cent ferric dimethyldithiocarbamate. Made by E. I. DuPont de Nemours Co., Wilmington, Del.

Isothan Q–15.—A liquid containing 20 per cent lauryl-isoquinolinumbromide. Made by Onyx Oil and Chemical Co., Jersey City, N. J.

Dithane D–14.—A liquid containing 25 per cent disodium-ethylene-bisdithiocarbamate. Made by Röhm and Haas, Bristol, Pa.

Dithane He–175.—A powdered form of disodiumethylene-bisdithiocarbamate. Made by Röhm and Haas, Bristol, Pa.

PREVIOUS HISTORY OF ORCHARD

The Kieffer pear blocks in which the experimental work was conducted were all located in the Teator Brothers orchard in the Red Hook area of Dutchess County. These trees were closely planted (16 × 16 feet) in 1908 and averaged more than 20 feet tall. The orchard was poorly situated with respect to both air and soil drainage and these conditions favored the development of disease.

In 1938, fruit counts were made during harvest in several pear blocks which had received different spray treatments during the year. The complete spray schedule in 1938 consisted of liquid lime-sulfur, 11 gallons to 100 gallons of spray mixture, at the cluster bud stage, April 15; bordeaux mixture (copper sulphate 2 pounds and lime 20 pounds in 100 gallons of spray mixture) at petal fall, May 3; and two applications of flotation sulfur paste, 8 pounds to 100 gallons, on May 26 and June 15. In five separate blocks which received the full

spray program, 58 per cent of the fruit was infected and trees in the most heavily infected block averaged 97 per cent fruit infection. Unsprayed trees and those with less than the full spray schedule were 100 per cent infected and 80 per cent were severely infected.

Some of the fruit was placed in commercial cold storage, but it kept very poorly due to shriveling following the loss of water from the infected areas.

In 1939, the same schedule was followed, but the two summer sprays of sulfur were delayed until June 10 and July 6, respectively. This schedule, plus a dry season, resulted in a fairly clean crop (10 per cent fruit infection), although unsprayed trees were 90 per cent infected. Unfortunately, Orthex was used as a sticker with the flotation sulfur paste in one block and 40 per cent of the fruit was injured from sun scald during a hot spell in July.

ERADICANT EXPERIMENTS, 1942–47, INCLUSIVE

The success of dinitro treatments for reducing the carry-over of the apple scab fungus (8) suggested the use of such materials as a means of controlling sooty blotch. The fact that the fungus overwinters on the surface of the twigs appeared to leave it in a very vulnerable position. The first eradicant treatment was started in 1942. A small block of about 15 trees was sprayed in a late dormant stage (April 7) with Elgetol, 4 quarts in 100 gallons, and no other sprays were applied during the year. The rest of the orchard was sprayed by the grower with 3 per cent lubricating oil in the dormant stage and one application of wettable sulfur in July. Harvest counts revealed 96 per cent fruit infection in the orchard which had received the oil and sulfur program and 89 per cent was so heavily infected it was thrown out of No. 1 grade. In the Elgetol block, 20 per cent of the fruit was infected but only 7 per cent was off grade (Table 1).

Two concentrations of Elgetol were tested in 1943, *viz.*, 2 quarts to 100 gallons as recommended for psylla control and 4 quarts to 100 gallons as used for sooty blotch the previous year. By harvest time, fruit from unsprayed trees averaged 29 per cent slight blotch and 52 per cent severe blotch. The Elgetol plots that received the lower dosage averaged 20 and 6 per cent slight and severe blotch, respectively, while the fruit from the plots sprayed with Elgetol 4 quarts to 100 gallons showed only 4 per cent slight blotch and no severe infections (Table 1).

TABLE 1.—RESULTS WITH DINITRO COMPOUNDS APPLIED AT THE GREENTIP STAGE FOR SOOTY BLOTCH CONTROL ON PEARS.

MATERIAL	AMOUNT IN 100 GALLONS OF SPRAY	PERCENTAGE OF FRUIT INFECTED*		
		Slight	Severe	Total
	1942			
Dormant oil†	3 gals.	7	89	96
Elgetol	4 qts.	13	7	20
	1943			
Unsprayed	——	29	52	81
Elgetol	2 qts.	18	4	22
Elgetol	4 qts.	4	0	4
	1944			
Unsprayed	——	38	56	94
Elgetol	2 qts.	49	5	54
Elgetol	3 qts.	19	1	20
Elgetol	4 qts.	23	2	25
D-296	4 lbs.	51	5	56
D-389	3 qts.	58	4	62
D-489	3 qts.	31	2	33
	1945			
Unsprayed	——	13	37	50
Elgetol	4 qts.	4	0	4
Krenite	4 qts.	14	5	19
D-296	4 lbs.	3	1	4
D-389	3 qts.	1	0	1
G-506	3 qts.	8	2	10

*From 8 to 10 trees were sprayed with each test material each tree receiving about 10 gallons per application. At harvest from two to four count trees were selected and all of the picked fruit was examined, except in the case of heavily loaded trees where a random sample of 500 fruits was examined.

†One July application of wettable sulfur was made on this plot.

The 1944 experiments were conducted in a younger block of trees planted in 1913 that were spaced 36 × 18 feet apart and therefore less subject to sooty blotch. However, these trees had not been sprayed the previous season and had become heavily infested. Elgetol was tested at 2, 3, and 4 quarts to 100 gallons. Three other dinitro materials tested included D–296 powder at 4 pounds to 100 gallons and D–389 and D–489 at 3 quarts to 100 gallons.

All treatments were applied when the blossom buds had swollen enough to show a little green tissue. Some browning of the exposed leaf tips occurred, but no serious injury resulted.

The fruit was harvested on September 22. In spite of the relatively dry summer in 1944, unsprayed trees averaged 94 per cent fruit infec-

tion, including 56 per cent below U. S. No. 1 grade due to sooty blotch.

Elgetol 3 quarts to 100 gallons was just as effective as 4 quarts to 100 gallons in controlling sooty blotch, but both of these concentrations were better than the 2-quart rate commonly used for psylla control. However, even this low concentration afforded fair commercial control with only 5 per cent severe blotch (Table 1). None of the other dinitro materials tested proved superior to Elgetol 3 quarts to 100 gallons in this test, but all gave commercial control with only 2 to 5 per cent severe fruit blotch.

The eradicant treatments made in 1945 were applied to the same block of trees that was used the previous season; and since the disease had been fairly well controlled in 1944, the conditions of carry-over were probably more like those in commercial orchards. The 1945 season was unusually wet, especially during July, August, and September. The season opened early, and although the treatments were applied March 29, the blossom buds had started to open and the leaf tips were exposed. Some browning of these tips occurred after the dinitro materials were applied, but no serious injury resulted.

The materials tested in 1944 were repeated in 1945 and Krenite was added. Various combinations of dormant dinitro applications followed by Fermate summer sprays were also tested.

Although unsprayed trees averaged 49 per cent fruit infection at harvest, plots sprayed with Elgetol at 4 quarts to 100 gallons; D–296 at 4 pounds to 100 gallons; and D–389 at 3 quarts to 100 gallons showed less than 4 per cent fruit infection (Table 1). Fruit from plots sprayed with G–506 at 3 quarts to 100 gallons and Krenite at 4 quarts to 100 gallons averaged 10 and 19 per cent infection, respectively.

In 1946, Kieffer pear trees were sprayed with Elgetol at 3 quarts to 100 gallons and at 4 quarts to 100 gallons, D–389 and D–289 at 3 quarts to 100 gallons, D–296 at 4 pounds to 100 gallons, and Krenite and Dinitrosol at 4 quarts to 100 gallons. The treatments were made on March 28 when the flower buds were swollen and showing some green around the outer bud scales. Due to spring frosts, the crop was very light in this orchard in 1946 and no summer sprays were applied. The few scattered fruits that were produced were examined at harvest and all of the dinitro treatments seemed to have given nearly perfect control as no fruit infected with sooty blotch was found on any of the sprayed trees.

These same treatments were repeated on April 24, 1947, with

equally good results as far as sooty blotch control was concerned. However, due to the light crop, no further sprays were applied during the season and the trees were defoliated by Fabraea leaf blight by September and the fruit was ruined by the same disease.

EXPERIMENTS WITH PROTECTIVE SUMMER FUNGICIDES

The occurrence of pear scab and Fabraea leaf and fruit spot sometimes requires the use of fungicidal spray applications during June and July. Sulfur and copper fungicides have been used for the control of sooty blotch in the past, but the copper materials often caused injury and sulfur was not completely effective. In these tests, a few organic fungicides were compared with wettable sulfur for sooty blotch control.

In 1944, Fermate, Isothan Q–15, and Dithane He–175 were compared with Micronized sulfur. The three applications were made on June 5, June 23, and July 13, and as this timing corresponded with the first three cover sprays for codling moth control, arsenate of lead at 3 pounds to 100 gallons was included with the fungicides.

The carbamate materials, Fermate at 1 pound to 100 gallons and Dithane He–175 at 1 pound to 100 gallons, gave the best control of sooty blotch with 6 and 3 per cent total fruit infection, respectively, compared with 16 per cent infection where Isothan Q–15 at 1 pint to 100 gallons was used and 27 per cent infection where Micronized sulfur 5 pounds to 100 gallons was used (Table 2). Unsprayed trees showed 97 per cent infection. Isothan Q–15 was the only material that resulted in injury this season. The injury was in the form of russet rings on the under side of the fruit where the spray dried slowly.

In 1945, Micronized sulfur 5 pounds to 100 gallons and Fermate at 1 pound to 100 gallons were used in three summer applications made on June 1, June 15, and June 30. Dithane D–14, Isothan Q–15, and 32R were discontinued after two applications when it was evident that they were causing considerable fruit and leaf injury. Arsenate of lead 3 pounds to 100 gallons was used with the fungicides and lime at 3 pounds to 100 gallons was added in the case of Dithane. Unsprayed trees averaged 49 per cent of the fruit infected with sooty blotch (Table 2). Trees sprayed with lead and lime showed 41 per cent infection. Three applications of sulfur reduced infection to 20 per cent and corresponding applications of Fermate reduced it to 5

TABLE 2.—RESULTS WITH SUMMER SPRAY TREATMENTS APPLIED FOR THE CONTROL OF SOOTY BLOTCH OF PEARS.

MATERIAL	AMOUNT USED IN 100 GALLONS	PERCENTAGE OF FRUIT INFECTED*		
		Slight	Severe	Total
	1944†			
Unsprayed	——	24	73	97
Micronized sulfur	5 lbs.	24	3	27
Isothan Q-15	1 pt.	15	1	16
Fermate	1 lb.	5	1	6
Dithane He-175	1 lb.	3	0	3
	1945‡			
Unsprayed	——	10	38	48
Arsenate of lead	3 lbs.	21	20	41
Micronized sulfur	5 lbs.	12	8	20
Fermate	1 lb.	4	1	5
Fermate§	1 lb.	0	0	0

*Eight to 10 trees were sprayed with each test material using 10 gallons per tree per application. At harvest from two to four count trees were selected and all of the picked fruit was examined, except in the case of heavily loaded trees where a random sample of 500 fruits was examined.

†In 1944, the sprays were applied June 5, June 23, and July 13.

‡In 1945, the sprays were applied June 1, June 15, and June 30

§This plot received an extra application on July 18.

per cent. A fourth application of Fermate on July 18 resulted in perfect control.

EXPERIMENTS WITH BOTH GREENTIP AND SUMMER APPLICATIONS

In 1944 and 1945, the dinitro spray plots were divided and some trees in each plot were sprayed with a fungicide during June and July and the rest were left without summer protection. In the first test, Isothan Q–15 at 1 pint to 100 gallons was used as the summer fungicide. Three summer applications resulted in 16 per cent fruit infection where no green tip spray was used. Plots that received Elgetol at 3 quarts to 100 gallons in the greentip stage and received no summer sprays averaged 20 per cent fruit infection. The combination plot that received Elgetol at greentip and Isothan Q–15 in one cover spray showed only 2 per cent fruit infection and those trees that received two cover sprays had less than 1 per cent fruit infection (Table 3).

Fermate at 1 pound to 100 gallons was used as the summer fungicide in 1945 and four applications were required to give perfect control. Three applications of Fermate in June gave about the same control as one Elgetol spray in March. Two June applications of Fer-

mate plus the Elgetol treatment gave no increase in blotch control over the Elgetol alone. However, a Fermate application on July 18 in combination with the early Elgetol treatment resulted in perfect control (Table 3). The plots that received only the dinitro spray suffered from Fabraea leaf and fruit spot, while those plots that received four applications of Fermate in June and July were free of this disease.

TABLE 3.—RESULTS WITH COMBINATION GREENTIP AND SUMMER SPRAY PROGRAMS USED FOR THE CONTROL OF SOOTY BLOTCH IN 1945.

TREATMENTS		PERCENTAGE OF FRUIT INFECTED*		
Greentip	Summer	Slight	Severe	Total
Unsprayed	Unsprayed	12	37	49
Elgetol†	Unsprayed	4	0	4
Unsprayed	Fermate, June 1, 15, 30‡	4	1	5
Unsprayed	Fermate, June 1, 15, 30 and July 18	0	0	0
Elgetol	Fermate, June 15, 30	4	0	4
Elgetol	Fermate, June 1, 15, 30 and July 18	0	0	0
Elgetol	Fermate, June 30 and July 18	0	0	0

*Eight to 10 trees were sprayed for each treatment. At harvest from two to four trees were selected and all of the picked fruit was examined, except in the case of heavily loaded trees where a random sample of 500 fruits was examined.

†Elgetol at 4 quarts to 100 gallons of mixture was applied March 29 at the greentip stage of bud development.

‡Fermate at 1 pound to 100 gallons of water was applied at the dates indicated.

DISCUSSION AND CONCLUSIONS

Dinitro materials have been shown by Mundinger (6) and Hamilton (4) to be effective ovicides for the control of pear psylla under New York conditions if applied at a late dormant or greentip stage. The concentrations generally recommended (2 quarts of liquid dinitro to 100 gallons) have not proved to be strong enough to kill the sooty blotch fungus which overwinters on the pear twigs. By increasing the concentration to 3 quarts to 100 gallons, good commercial control of sooty blotch was obtained without the aid of any summer fungicide. The control obtained with various dinitro materials as greentip applications compared favorably with that obtained from three applications of a protective summer fungicide.

Under conditions where sooty blotch was well established and weather conditions were favorable for disease development, neither the greentip application nor the three summer applications alone gave complete control of sooty blotch, but a combination of both early and late applications did give good control. During the course of these

experiments, Fabraea leaf and fruit spot became a problem in the experimental orchard and required a late summer fungicide application for its control. The combination of dinitro applied early for psylla and sooty blotch and a summer application or two of Fermate in late June and mid-July to control secondary sooty blotch and Fabraea leaf and fruit spot afforded the best all-around control.

The fact that the dinitro treatments eliminate severe blotch but do not completely eliminate late sooty blotch infection may indicate that the overwintering fungus was not completely killed. It may be that only the spore-bearing pycnidia were injured and that summer spores, as described by Colby (2), were formed later in the season and resulted in late infection which did not have time to develop into the russet type of fruit lesions. Another possibility is that these late infections are the result of summer spores blown in from unsprayed trees near the dinitro plots. In the latter case, the treatment of the entire orchard could be expected to give better results than if only part were treated, as was the case in the experimental plots. Further experiments will be required to answer these questions.

For the present it appears likely that the use of dinitro sprays on the whole orchard each season will reduce the incidence of sooty blotch to a low level. In cases where the disease is serious at the start of the season, a combination spray schedule of both dormant and summer applications may be required.

SUMMARY

Field experiments were conducted for the control of sooty blotch, *Gloeodes pomigena* (Schw.) Colby. Both greentip applications of dinitro materials and summer applications of sulfur or organic fungicides were tested.

The 2-quart or 2-pound concentration of dinitro toxicants generally recommended for pear psylla control was not sufficient for the control of sooty blotch. Elgetol at 3 quarts to 100 gallons gave satisfactory results in the experimental tests, but with some of the products tested 4 quarts of liquid or 4 pounds of powder were required for adequate control under orchard conditions where sooty blotch was a serious problem.

Dinitro materials applied at the greentip stage furnished the same degree of control as three applications of a good summer fungicide.

Fermate at 1 pound to 100 gallons applied three times during June

and July afforded better control of sooty blotch than wettable sulfur and avoided the injury that sometimes resulted when sulfur applications were followed by high temperatures. Several other organic fungicides were effective in controlling the disease, but they caused too much injury.

Where sooty blotch was a serious problem, a combination of a dinitro application at the green-tip stage followed by Fermate in two late cover applications was required for complete protection.

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ABSTRACT

INFORMATION concerning the fungus *Gloeodes pomigena* (Schw.) Colby that causes the sooty blotch disease of apples and pears is briefly reviewed.

Records taken in a Kieffer pear orchard prior to the present investigation showed that the wettable sulfur spray programs which omitted the late June and July fungicide applications (third to fifth codling moth covers) failed to give adequate protection from sooty blotch. Such plots often had 100 per cent fruit infection. Close planting and poor air drainage were contributing factors in disease development.

Data are presented on the results of field tests of various dinitro materials applied at the green-tip stage of pear development for the control of sooty blotch. These trials indicate that where sooty blotch is a problem, the concentration of dinitro materials must be increased to about twice that necessary for pear psylla control.

In general, 4 quarts of the liquid products or 4 pounds of the powdered forms were needed in 100 gallons of water for effective control. Where this early spray was thoroughly applied, no summer fungicide applications were required for this disease under ordinary circumstances.

Under conditions especially favorable for disease development, some late infections developed in the dinitro plots. In order to control this and other diseases, such as Fabraea leaf and fruit spot, it was necessary to make one or more summer applications of sulfur or Fermate in order to keep the crop clean. Of the summer fungicides tested, Fermate showed the best control with the least injury.

Without the dinitro sprays, as many as four summer applications of Fermate were required to give complete protection from sooty blotch.

Since the use of dinitro materials are commonly recommended for pear psylla control, it seems worth while to increase the concentration used where sooty blotch is a problem so as to prevent disease development.